

Synergies between ergoecology and green ergonomics: a contribution towards a sustainability agenda for HFE

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Abstract. This paper analyses two proposals that seek to contribute to sustainability from an HFE perspective: ergoecology and green ergonomics. It presents both approaches, their principles, purposes, and fields of application, thereafter dealing with their context of emergence, and overlaps in purpose, principles, and shared values. The principles of ergoecology are given as a framework for developing analytical or practical actions while the principles of green ergonomics are given as guidelines for proposing concrete interventions. Social responsibility and environmental/ecospheric responsibility are the leading threads of ergoecology and green ergonomics, embedded in several values. Implications of these synergies for HFE are outlined.

Keywords. Ergonomics, ergoecology, green ergonomics, sustainability

1. Introduction

“Sustainability”, in its modern sense, has come to mean the management of scarce resources for the use of current and future generations. This is a somewhat narrower conceptualisation than the dictionary definition which essentially means being supported indefinitely (Johnston *et al.*, 2007). Nevertheless, sustainability is a theme that is currently being tackled by many disciplines, and Human Factors and Ergonomics (HFE) is no exception. Within this discipline, some authors suggest that sustainability is already implicit in HFE, taking into account several HFE definitions and the work towards corporate sustainability (Zink & Fischer, 2013). Other authors doubt that this view is sufficient and claim that ergonomics needs to review its entire knowledge base if it really wants to contribute to sustainability (Dekker *et al.*, 2013). Considering this discussion, this paper analyses two proposals that seek to contribute to sustainability from an HFE perspective: ergoecology and green ergonomics, by asking the following questions:

- What is the context of the emergence of ergoecology and green ergonomics?
- How are the purposes and principles of both approaches related?
- What are the shared values of both approaches?

2. Methods

The analysis was done as follows: (1) review of the basics of ergoecology and green ergonomics; (2) analysis of principles, purposes, and fields of application; (3) analysis of

their context of emergence, (4) comparison of both approaches regarding their overlaps in purpose and principles, and (5) deduction of shared values.

3. Results

3.1 *Basics of ergoecology*

García-Acosta (1996; 2002) coined the term ‘ergoecology’ to describe a hitherto undeveloped multidisciplinary field, introducing ties between ergonomics and ecology. It is defined as a multi-discipline studying human beings and their relationships with the environment by analysing their activities to establish the impact (positive or negative) of this relationship (García-Acosta et al, 2012a). Ergoecology is conceptualized as the product of the interaction between an ergonomic system [human being (HB), objects/machines (O/M) and physical space (PS)] and the systems’ surroundings i.e. political-legal (P-L), economic-financial (E-F), social-cultural (S-C), technological-scientific (T-C), and ecological-geographical (E-G) factors (henceforth PESTE Factors), focusing on the ecological-geographical factor.

Regarding the field of application, ergoecology can be implemented in the primary, secondary, and tertiary sectors (García-Acosta et al, 2012a). It offers a framework for developing more holistic approaches and methods for analysing and developing processes and products. For example, the concepts and related axioms for assessing the flow of energy, raw materials and information (García-Acosta et al, 2012b) among macrosystems (sociotechnical and natural systems) or within systems (processes) are one way of establishing the sustainability of the system.

The principles of ergoecology are as follows: (1) an anthropocentric approach but with the capacity of assuming an ecospheric perspective; (2) focus on sustainability; and (3) systems approach (dynamic and holistic).

3.2 *Basics of green ergonomics*

Green ergonomics is defined as ensuring human and natural system wellbeing through understanding the bi-directional relationships between natural and human systems (Thatcher, 2013). From a green ergonomics perspective it is not possible to have sustainable human wellbeing and effectiveness when the natural environment becomes degraded and depleted. Natural environments that lack essential resources (e.g. nutritious food, fresh water, clean air, plants for carbon sequestration, nutrient-rich soil, etc.) or contain harmful waste products (e.g. volatile organic compounds, excessive heavy metals, etc.) are not places that facilitate human wellbeing and effectiveness.

Green ergonomics plays a role on the one side of the relationship in the conservation and preservation of natural systems and, more actively, the restoration of natural systems. On the other side of the relationship, natural systems provide a range of services that can be harvested by humans for a range of human benefits. This component of green ergonomics includes recreational facilities for human psychological restoration and physical activity, and for drawing inspiration and creative energies. Its application areas fall into three categories; the design of low resource systems and products, the design of green jobs, and the design for behaviour change.

The principles of green ergonomics are as follows: (1) eco-efficiency, eco-effectiveness, and eco-productivity; (2) ecological resilience; (3) indigenous/vernacular systems; and (4) a focus on learning from natural systems (Thatcher et al, 2013).

3.3 *Analysis of context of emergence*

Ergoecology (1996) was proposed based on an historical and theoretical reflection

about ergonomics, its borders and opportunities for further development, while green ergonomics (Hanson, 2010) appeared as a concern for how ergonomics and human factors can contribute to avoid the destruction of the planet. Although both proposals point to the same goal, the historical circumstances were quite different. The idea and need for sustainability was not, in 1996, an everyday topic, as it is now. The circumstances surrounding the emergence of green ergonomics demand rapid and effective interventions.

3.4 *Overlaps in purpose and principles*

The principles of ergoecology (anthropocentric focus with ecospheric perspective; focus on sustainability; systems approach) are given as a framework for developing analytical or practical actions while the principles of green ergonomics (evaluation, design and innovation for eco-efficiency, eco-effectiveness, and eco-productivity; evaluation, design, and innovation consistent with ecological resilience; evaluation, design, and innovation for indigenous/vernacular solutions; acknowledge how natural systems value “design“) are given as guidelines for proposing concrete interventions.

Both approaches share the same purpose and their principles overlap. The difference lies more in their scope. Ergoecology offers a wide framework for developing approaches like green ergonomics, and for the exploration of other macroergonomic approaches concerned with sustainability, and the intervention and management of sociotechnical systems and ecosystems as relational contexts. For example, fields of action like “supply chain ergonomics” and “life cycle ergonomics” as proposed by Zink (2013), could greatly benefit from an ergoecological perspective. Meanwhile, green ergonomics has a more practical focus, privileging design interventions rather than studying the relations themselves or the deduction of concepts and fundamentals for establishing theories.

3.5 *Shared values*

A number of authors have stressed the importance of values in HFE (Dekker et al, 2013; Wilkin, 2010). A careful examination of ergoecology and green ergonomics reveals common shared values. The underlying thread to these values reveals an ethical responsibility in two directions: environmental/ecospheric responsibility and social responsibility. As an applied human science HFE has historically focused on human rights (see the ethical codes of conduct from the IEA, the HFES, the German Ergonomics Society, and the IEHF). However, both these theoretical approaches also call on us to respect the life-giving and life-sustaining resources and services provided by the natural environment. Table 1 summarizes these shared values.

Table 1. Summary of shared values

Value	Relation to ergoecology and green ergonomics
Respect for the Earth	Mosquin and Rowe (2004) outline a set of core principles that emphasise the importance of the ecosphere in providing natural resources to enable and sustain life. A purely anthropocentric approach ignores (or, at best, under-emphasises) the fact that we share this ecosphere with a range of other inter-related biological entities and non-biological systems. To preserve and sustain our own (anthropocentric) existence it is necessary to respect these ecocentric realities. Both ergoecology and green ergonomics emphasise respect for our own place in this broader natural reality, valuing ecological and cultural diversity while supporting social justice (Mosquin & Rowe, 2004).
Respect for	The second value is that of an anthropocentric principle. Thatcher (2013)

Value	Relation to ergoecology and green ergonomics
human rights	emphasizes that humans are part of the natural environment, and in this way, a focus on the ecology of natural environments is also necessarily anthropocentric. It must be noted that within these theoretical approaches, anthropocentrism is not as narrowly defined as it is in more traditional HFE approaches. Here, a respect for human rights means a respect for a more socially responsible approach, acknowledging the need for social redress and more globally equitable access to economic, social, technological, political, and natural capital. It is interesting that approaches more common in (older) societies are more connected with their natural environment than societies that have removed themselves (technologically) from the natural environment.
Respect for ethical decision-making	The third value builds on the first and second values in that a socially responsible and ecologically responsible approach requires ethical decision-making. Design often means making difficult choices between non-ideal alternatives and these decisions are often guided by internal and external politics. Unfortunately, many disciplines, including HFE, have a rather poor record of considering global human rights and respect for natural systems. The existing codes of conduct and codes of ethics emphasise open declarations of expertise, integrity, fairness, objectivity, privacy, and harm reduction (to the humans, but not to nature, in the target system). Decisions should, however, be made based on the “best” solution for the entire system bearing in mind ecological equity and the socially responsible distribution of resources. It is our contention that ethical codes should go further to respect human dignity and equity in the distribution of resources. Further, there is a requirement for ethical codes of conduct to respect and protect the natural systems from which our resources are drawn.
Respect for transparency and openness	The fourth value builds on the precautionary principle emphasized in green ergonomics. This value requires us to acknowledge the uncertainties and to be open about when an intervention does not have the desired positive social, economic, or environmental impact. Dekker et al (2013) noted that there are numerous potential instances where unjust practices have occurred (and might even be allowed to perpetuate into the future), but that it is a moral responsibility of HFE to make these unjust relationships known to system users. They also suggest that HFE would have to embrace an understanding of the unintended consequences of ergonomic decision-making and actively seek ways to ameliorate these impacts. For these authors, this is the duty of all of HFE, not just those specialists interested in sustainable development.
Respect for complexity	This value builds on our understanding of transparency by acknowledging that the systems under investigation are complex with multiple uncertainties, where predictability is difficult and at best complex. All the authors working within the theory of human factors and sustainable development arena (García-Acosta et al., 2012a; Thatcher, 2013; Zink & Fischer, 2013) emphasise complex interrelationships between human and environmental systems, although the actual components differ. Both Wilkin (2010) and Dekker et al (2013) emphasise that we are increasingly having to deal with complex, open systems. Wilkin (2010) places emphasis on the complex social systems (especially political and socio-economic systems) while Dekker et al (2013) expand this thinking to include interrelationships with natural systems. Dekker et al (2013) encourage us to embrace this complexity. In fact, they suggest that the naming of system components is less important than the understanding that they interrelate in complex and often unpredictable ways. One aspect of complexity that is emphasised in the theoretical approaches, but is rarely incorporated into the HFE models is the time dimension, although Zink’s (2013) latest work does make an attempt.

Value	Relation to ergoecology and green ergonomics
Respect for diversity	<p>The value of respect for diversity embraces human variability as well as ethnic and geographic diversity, and the diversity of other species (i.e. cultural diversity, human variability, and ecological diversity). It is recognized from natural systems that diversity allows systems to build in adaptability and resilience to change. One specific aspect of diversity that is acknowledged is respect for local identity. This means accepting that local and indigenous solutions should often have precedence over solutions that attempt to enforce ‘global’ solutions. Related to this value is the acknowledgement of local expertise and knowledge. The codes of ethical conduct assume that HFE experts have the knowledge and the intention of doing good, but they also assume that the HFE experts have the best solutions for the situation being intervened. However, the ethical decision-making promoted in ergoecology and green ergonomics highlights the recognition of local expertise in line with the participatory ergonomics approach (Imada, 1991). It is important to note that in this context we do not view participatory ergonomics being used by the HFE specialist to arrive at a democratically emergent single “best” solution.</p>

4. Discussion and Conclusion

Sustainability and sustainable development are themes of great importance for the HFE community. Ergoecology proposes a multidiscipline for systematically studying the relationship between human activities and the natural environment. Green Ergonomics offers an approach to research and implement interventions with a pro-nature focus.

The expansion of traditional ergonomics to macroergonomics in the 1980s was because ergonomists realized that facing and solving specific problems at the workstation interface was not enough to generate large improvements. Through this initiative a shift was generated, and the social dimension of sustainability gained more importance. We believe there is a need for a new shift towards not just the ecological dimension of sustainability (without forgetting the other dimensions), but also including the political and technological dimensions of sustainability. The essence of ergonomics relies on the interactions between the social and the technical components, but both depend on the ecological component, and are determined by the economic and the political components.

Social responsibility and environmental/ecospheric responsibility are the leading threads of ergoecology and green ergonomics. These statements are embed in six values: respect for human rights, respect for the Earth, respect for ethical decision-making, acknowledgment of complexity, respect for transparency and openness, and respect for diversity. Aside from the ecological component, values are the common aspect of all dimensions of sustainability.

We consider that a sustainability agenda for HFE should be based on how these values can be embedded into concrete practices of HFE. In essence, it is not a problem of labels, tools or methods, but of a change in worldview that guides the actions of HFE specialists. In line with this, education and awareness of the mentioned values should be the first point on the agenda. This point alone could contribute significantly to the desired shift in HFE towards sustainability.

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